

the problem. Procedures are needed which quantify potential claims and judgments and relate these to agency functions (design, construction, maintenance, etc.) and to highway elements and features (ditches, guardrail, sign supports, etc.).

The last chapter of the synthesis contains specific action guidelines for each agency function. These may be used as a checklist of ideas for consideration and implementation.

III. & IV. DISCUSSION GROUP RESULTS
Jack Humphreys

Prior to the meeting, separate lists of problems/issues for the topics of Planning, Design

and Construction (Table 3) and Operations and Maintenance (Table 4) were prepared by the workshop organizers. These were to serve as starting points for the group discussions. It was acknowledged that duplication existed between problems and lists. Groups were also told to freely add other problems/issues discussed, as well as identify solutions and/or recommend research. Results are shown below. Problems/issues numbers and short titles generally refer to Tables 3 and 4, unless a discussion group for the two major topics.

Topic 1. Planning, Design and Construction

Group 1

Problems/Issues Prioritized

1. Lack of communication to state-of-the-art engineering knowledge and research results to design, construction and maintenance personnel (New Item).
2. Problem of limited funds precluding immediate and full adoption of all recommended safety standards (Item #2, Table 3).
3. The inability to design and test safety appurtenances with unusual design vehicles (Item #3).
4. Accident problems in construction zones (Item #5).
5. Design standards do not consider all persons "legally" using the roadways (Item #11).

Suggested Solution or Recommended Research

Develop an approach (may require research) that supplies design, construction and maintenance personnel with the latest technology in regard to highway safety appurtenances and other roadway features so that the technology can be applied sooner.

The cost effectiveness approach to allocating limited funds tends to be accepted as reasonable by juries. (Juries make similar deliberations about the value of a life.) This approach should be followed. The cost effectiveness approach needs to be continually refined to take into account new research findings about both costs and benefits.

Technology does not exist to design all barriers for all vehicles. There is a need for more compatibility between vehicle and roadway designers. The minicar presents a particular problem. Need data concerning the minimum vehicular weight that can be accommodated. General consensus is to at least consider "giving notice" to vehicle operators that safety features on some or all roads have not been designed or tested with certain classes of vehicles.

More research needed to develop appropriate standards for various classes of construction zones. Need guidelines for temporary barriers. Recommend a rewriting of Part 6 of the Manual of Uniform Traffic Control Devices.

There is concern that current designs may be ignoring a large percentage of drivers "legally" using the roadway. More consideration should be given to designing for the "impaired" driver (e.g., a driver with a 0.02% BAC level). This might approximate those drivers using the roadway who are impaired by stress, fatigue, etc. Such an approach would be considered reasonable by juries.

Table 3. Discussion Topics in the Area of Planning, Design and Construction.

1. Many accidents involve the "innocent bystander." Examples are a median crossover accident, an accident in which a vehicle penetrates an overpass and strikes traffic below, an accident in which a vehicle encroaches into a rapid transit busway or railway, etc. Should more emphasis be placed on prevention of these types of accidents as compared to single vehicle, run-off-the-road accidents?
2. Increasing demands are being made of transportation agencies in the area of highway and roadside safety. Limited funds preclude immediate and full adoption of all recommended safety standards. Many agencies are now using cost effectiveness of benefit/cost analysis procedures to evaluate alternate safety programs and to establish priorities and action plans. These procedures typically require that estimates be made of the monetary value of life, a very sensitive issue. Is this the most rational approach to establish priorities and policies? Do the courts view these as rational, acceptable procedures? Is there a better way?
3. Many accidents which lead to court cases involve "unusual" conditions; for example, cases involving motorcycles, high-ride, four-wheel drive pickups, recreational vehicles, cars or campers pulling trailers, trucks and buses. Safety appurtenances are not designed or tested with these "special" vehicles, yet the plaintiff often contends that there should have been a safety device in place that could handle them.
 - a. Should safety devices be designed to handle all types of vehicles legally allowed on state highways? On local roads?
 - b. If not all types can reasonably be accommodated, which types can be?
 - c. To what extent should the federal government encourage or regulate the use of "universal" safety appurtenances?
 - d. Is there any way in which a state or local agency could "give notice" to vehicle operators that safety features on some or all roads have not been designed or tested with certain classes of vehicles, and the governmental agency is not responsible for any accidents involving safety features and these special classes of vehicles? In other words, could this be accomplished by the highway agency with signing, or by legislation (e.g., issuing warnings when vehicles were registered), or by requiring special high limited insurance for selected classes of vehicles?
 - e. If more versatile safety appurtenances are desirable, inadequate funding for research and construction is the main roadblock to their development and implementation. What efforts should be made to increase funding? For example, should "special" vehicles pay extra fees to finance "universal" safety appurtenances? Or should all vehicle operators allowed on public roads have "equal" safety at equal cost to them?
4. Accidents occur where vehicles impact a barrier at a 45° - 90° angle, while skidding sideways, while yawing rapidly or heading backwards, while braking so the car noses down under the barrier, etc. We do not design or test barriers for these conditions, yet sometimes plaintiffs contend that the barriers should function under these conditions.
 - a. Should barriers handle a wider range of impact condition?
 - b. What are reasonable limits, if any, for barrier impact conditions? Should these limits be established and officially adopted by AASHTO? FHWA?
 - c. Should a research project be initiated to conduct tests at some extreme conditions on standard barriers, for example 90° impacts?

These tests would clearly show that the barriers do have limits and might not be helpful under these impact conditions. Movies of these tests could be used for accidents where no barrier was present.
5. Construction zones continue to cause problems.
 - a. What safety standards now exist?
 - b. What research or new standards are needed?
 - c. How can standards best be enforced?
 - d. Should construction zones have the same level of safety as up-to-date roadways?
6. Problems arise because legal cases go to trial several years after the accident and there is minimal information on the accident and on the highway condition at the time of the accident.
 - a. What highway condition information is most helpful to attorneys such as photologs, as-built plans with all changes, etc.?
 - b. Are multidisciplinary accident investigation team examinations helpful? Should their procedures be modified? Should they expand on the number of cases investigated?
 - c. What type of traffic accident records are needed? How best provided?
7. Utility poles -- When and how should they be safety treated?
8. Guardrail end treatment -- What is the preferable design? BCT? Twisted and turned-down end?
9. Designers of highway safety hardware are continually having to play "catch-up" with the motor vehicle industry in order to design

functional items of safety hardware. What can be done within the vehicle industry to ensure greater compatibility between vehicles and highway safety hardware? Is this an area for NHTSA?

10. Because of increased development older rural roadways frequently carry increased volumes at increased speeds. Planning agencies may propose and/or program improvements for realigning and/or upgrading these roadways to provide better levels of service.

a. To what extent should spot safety upgrading be done in the interim? (Guardrail, tree or utility pole removal, etc?)

b. What are the legal implications if local citizen opposition delays the implementation through harassment, stalling tactics or legal means, and accidents occur on older roadway which does not include the latest safety features?

11. Is it possible to develop a "design driver" for whom the roadway environment is designed, or is the necessary to design for all persons "legally" using the roadways? (Note: This is a similar question to the "design vehicle" topic already on the list.)

12. To what extent should "normal" highway design standards apply to scenic highways, park roads, etc.? Should specific guidelines be developed by agencies other than, for example, the National Park Service? (Scenic barriers, such as rock walls, vs. guardrail, for example.)

13. Improper signing is often claimed as a defect in the highway.

a. What have we learned about signing requirements?

b. To what extent must all hazards or possible hazards be signed?

Table 4. Discussion Topics in the Area of Operations and Maintenance.

1. Problems arise because of obsolete barriers. There are hundreds of miles of these still in existence.

a. What type of upgrading program should highway agencies use?

b. How should it be documented?

c. How long is it reasonable to leave an obsolete barrier in place?

d. Some older barriers may have vehicle containment properties but, on balance, are not quite as good as newer barriers. How can this concept be promulgated, that the older barrier is not extremely hazardous and obsolete just because it is no longer a standard, and that a newer barrier only has a few additional assets?

2. Problems arise when accidents occur at locations that have a history or reputation of being hazardous.

a. When citizens make complaints about a "hazardous" roadway, what is the best way to handle these complaints, in light of possible future legal cases due to accidents at those locations?

b. Should highway agencies do periodic inventories of highway locations that need safety improvements?

c. How should these be documented? What language should be used?

d. What is a reasonable time period in which to upgrade these locations?

e. To what extent is lack of funding an excuse for delaying improvements? How should this be documented?

3. Problems arise when highway agencies don't follow their own manuals; for example, by not installing a median barrier as soon as it is warranted in the manual.

a. How should manuals and other policy guidelines be written to minimize problems?

b. If a highway agency has insufficient funds, for example, to do maintenance work mandated in a maintenance manual, how should this be documented, both at the state agency level and at the local maintenance station level?

c. How often should manuals be reviewed and updated?

d. How often should design, construction, operations and maintenance people be given refresher training on agency standard specifications, plans, manuals, procedures, test methods, etc.? How critical is training in the prevention of legal problems? What type of training is most useful?

4. Problems arise because of lack of communication between the engineering and legal division of a highway agency.

a. What forms of communication would be useful other than that occurring on individual legal cases?

b. Would a permanent joint committee of engineers and attorneys have any value?

c. Would it be helpful if the legal division prepared an annual report summarizing the type of engineering problems they had encountered in legal cases the previous year?

d. Many cases are similar and require a collection of the same set of reports, standards, movies, etc., by the engineer for the attorney. Is there value in

- preparing a standardized basic packet of information for common types of legal cases to reduce engineering time and ensure completeness of coverage? Should agencies prepare, for example, a "history of median barrier" which includes all previous standard plans and specifications, and describes changes in design, warrants, etc., through the years? Is there a reason why attorneys would prefer not to have these histories or information packets in existence?
- e. What are the pros and cons of having engineers and/or attorneys who specialize in certain types of cases?
5. Sometimes attorneys and engineers do not realize pertinent information is available, either within their own agency or from other states. For example, many agencies are unaware of edge-of-pavement dropoff tests CAL-TRANS did 10 years ago, or the ones done recently at TTI.
 - a. Would there be value in having a specialized information service related to highway safety design and tort liability cases?
 - b. Would a new TRB committee or a permanent subcommittee of TRB A2A04 be helpful in keeping highway safety subjects that were directed toward engineer and attorney users?
 - c. Could one or more transportation libraries compile automated bibliographies on selected highway safety subjects that were directed toward engineer and attorney users?
 - d. Would it be useful to have a periodical in which highway safety cases were reported briefly in simple language? Does such a periodical exist now?
 - e. What training classes should agency attorneys provide agency engineers and vice versa?
 6. Vegetation control -- How can problems of reduced sight distance, large trees in the clear zone, and grass and/or ground cover around breakaway sign and luminaire support be minimized?
 7. Restoration of damaged, substandard hardware -- Must it be restored to its original condition? To full current standards or something less but better than substandard system?
 8. Routine maintenance of safety devices -- How can this be achieved in a timely manner?
 9. Where roadside features contrary to good safety practice are required or mandated by "others," how do we protect ourselves or assign the responsibility. Such things as utility poles, trees, monuments, etc. should be considered.
 10. When is operational maintenance justified over preventative maintenance for highway safety hardware, if at all?
 11. Pavement surface and pavement edge discontinuities (potholes, edge dropoffs, dips, bumps, etc.) -- When should corrective measures be taken?

Group 2
Problems/Issues Prioritized

1. Lack of feedback to the highway departments concerning the number and disposition of tort claims involving their highway system (New Item).

Suggested Solution or Recommended Research

Highway engineers occasionally get involved as experts in tort claims but have no information concerning the volume of claims broken down by type of highway involved, urban or rural, construction zone, principal highway deficiencies claimed, crash circumstances, type of vehicle, dollar amount if pre-trial settlement, court judgment amount, etc. Legal office should provide such information as cases are settled in the form of quarterly and/or annual summary reports. Recommend research to study tort claim settlements and decisions in at least several government jurisdictions to determine what feedback would be of value to highway engineers responsible for the establishment of warrants and priorities for highway safety improvements.

2. The inability to design and test safety appurtenances with unusual design vehicles (Item #3).

Not physically or economically possible to test and design for all vehicles (e.g., motorcycles would need to be redesigned to give the rider better protection). Can accommodate vehicles weighing 1,800-10,000 pounds. Could accommodate vehicles up to 25,000 pounds for median barriers, bridge railings and guardrail in "innocent bystander" locations. Other heavier vehicles could be handled in special, high-risk situations. The federal government should only encourage the use of adequately tested designs.

Availability and economics generally bring about universal hardware. However, flexibility must be allowed for different environments and material availability in different geographic areas. In their normal oral and written communications, the state motor vehicle and driver registration departments could make the driving public more aware of the potential dangers associated with the various vehicle/safety appurtenance interactions. In considerations to increase funding, some special vehicles already pay higher "use" fees in most states to finance costs induced by their operation. Recommend research to initiate a national study to develop the information that could be disseminated in a public awareness campaign to alert drivers to the potential dangers associated with certain vehicle/appurtenance interactions.

3. Accident problems in construction zones (Item #5)

The only universal or national safety standards for construction zones relate to signing. Some state highway departments (e.g., California) already have developed and now have some years of experience with fairly detailed standards or procedures to other states and local governments. Safety standards can best be enforced by developing a traffic control plan which also establishes the responsibility of the contractors or engineers before work commences. Whenever physically and economically feasible, should have at least the same level of safety as the existing road approaching at each end. If this is not possible, speed restrictions should be considered.

4. The "innocent bystander" accident and the tendency of juries to pay larger and more frequent amounts to innocent parties (Item #1).

More emphasis should be placed on the prevention of accidents involving median crossover, dropping from a bridge onto traffic below, crashing into a school yard, etc., as compared other types of run-off-road accidents. A means of quantifying the emotional value of innocent bystander accidents would be helpful in establishing warrants or making cost/benefit studies aimed at establishing the priorities for the correction of roadside safety problems. Recommend research to study tort claim results (wins, losses and settlements) in terms of highway safety functions could lead to the development of numerical emotional factors and where or when they should be applied.

5. When and how should utility poles be safety treated (Item #7).

A recent cost-effectiveness study recommends: (1) every effort should be made to move the pole away from the roadway, (2) if relocation is not possible, consider underground line placement, thereby eliminating the pole, and (3) consider the breakaway technique if the aforementioned are not feasible. Recent research at TTI and SwRI has developed tested techniques for breakaway poles that appear workable. A major problem appears to be failure to get the highway department or utility company to initiate action to move pole(s). Consider research to document the reasons why utility pole accident problems are not being solved simply by relocation. The study should involve areas or locations where utility pole accident rates are high.

Group 3
Problems/Issues Prioritized

1. Lack of a Model Tort Liability Act (New Item).
2. Legal cases go to trial several years after the accident (Item #6).

Suggested Solution or Recommend Research

Prepare a model Tort Liability Act following the guide of the model Traffic Ordinance and recommend the act to the states for their consideration. (Note: Don Woods, Texas Transportation Institute, has prepared such a draft document.)

Engineers and lawyers should discuss serious accidents shortly after their occurrence. No pertinent information should be withheld from attorneys. A

- | | |
|--|--|
| 3. The inability to design and test safety appurtenances with unusual design vehicles (Item #3). | detailed investigation of all serious accidents, including photographs, should be implemented.

It may be appropriate to "give notice" to vehicle operators that safety features on some or all roads have not been designed or tested with certain classes of vehicles. Licensing or registration pertaining to unusual vehicles could be a useful time to inform operators. Recommended research to establish procedures regarding what vehicles can be designed for and tested. |
| 4. The extent to which spot safety upgrading should be done (Item #10). | Warn of problem locations by special signing or advisory speed zone. Take actions for known (proven) hazardous locations or situations. |
| 5. Unqualified expert witnesses (New Item). | Try to utilize the appropriate technical society or professional engineering registration process to take action against unqualified or unethical witnesses. Guidelines should be prepared for: (1) certification of technical experts for various aspects of the highway, and (2) ethical behavior as an expert witness. |

Group 4

Problems/Issues Prioritized

- | <u>Problems/Issues Prioritized</u> | <u>Suggested Solution or Recommended Research</u> |
|--|--|
| 1. Guardrail end treatments remain hazardous (Item #8). | Continue research with various end treatments. Disseminate findings. |
| 2. Timing of development of standards relative to new technology developed through research (New Item). | Try to avoid premature adoption of standards prior to the conduct of needed research. Example include passenger vehicle downsizing, barriers for trucks and buses, and multi-service level criteria for traffic railings. |
| 3. Recent accident data (Unpublished) tends to show larger impact angles and many instances (perhaps 50%) of yawing in traffic railing accidents (Item #4). | Conduct crash testing in conjunction with computer simulation based on the finding of studies providing insight as to impact condition |
| (Note: This problem/issue is certainly related to Item #'s 3 and 11. Item #4 receives the priority over #3 (unusual vehicles) because it is thought to be more researchable. Item #11 (developing a design driver) is thought to be at least an order of magnitude more difficult to research than Item #4). | |
| 4. The "innocent bystander" accident and the tendency of juries to pay larger and more frequent amounts to innocent parties (Item #1). | Consider the amounts juries pay to innocent victims and utilize this in cost effectiveness evaluations. Recommend research to determine what the additional cost factor is that results from juries giving more frequent and more generous awards to innocent victims. |
| 5. Accident problems in construction zones (Item #5). | Develop safety standards for construction zones. Develop criteria for lowering standards (if applicable) for maintenance zones. Investigate the nature of accidents in both construction and maintenance zones. |

Topic 2 - Operations and Maintenance

Group 1

Problems/Issues Prioritized

- | <u>Problems/Issues Prioritized</u> | <u>Suggested Solution or Recommended Research</u> |
|--|---|
| 1. Pavement surface and pavement edge discontinuities (Item #11, Table 4). | Identify extent of dropoffs, potholes or bumps that lead to incorrect responses by unaware drivers. Prepare a synthesis based on best knowledge available. (Note: Some recent guidelines published by TTI in Research Reports 328-1 and 328-2F. Also Special Report by select TRB study group entitled "The Influence of Roadway Surface Discontinuities on Safety.") |
| 2. Lack on communication between engineering and legal division of a highway agency (Item #4). | Highway agency legal section recommended where not present now. Attorneys should specify accident information needs. Develop staff investigator to conduct proper examination of serious accidents. |

- | | |
|--|--|
| <p>3. Routine maintenance of safety devices (combination of Items #8 and #10).</p> <p>4. Restoration of damaged, substandard hardware (combination of Items #1 and 7).</p> <p>5. Failure of highway agencies to follow their own design manuals (Item #3).</p> | <p>Recommend professional development program for attorneys and engineers who deal with tort liability.</p> <p>Compile synthesis of maintenance of roadside elements. Develop maintenance priorities.</p> <p>Do not replace in-kind if newer specifications. Inventory systems to determine: (1) that the system functions, and (2) that the system meets the original specifications. Prioritize replacement accordingly, perhaps with the use of a time-phase program. Maintenance staff must receive current information about new hardware and techniques for upgrading older hardware.</p> <p>Continuous review of manuals to keep current. Engineering and legal staffs need to decide on allowable tolerances in any deviations for items like pavement dropoffs. Develop timing for various inspection procedures.</p> |
|--|--|

Group 2
Problems /Issues Prioritized

1. Obsolete or older barriers (Item #1).
2. Failure of highway agencies to follow their own design manuals (Item #3).
3. Lack of communication between the engineering and legal divisions of a highway agency (combination of Items #4 and #5 - a tie in actual priority).
4. Problem of accidents occurring at hazardous locations (Item #2).

Group 3
Problems/Issues Prioritized

1. Obsolete or Older barriers (Item #1).

Suggested Solution or Recommended Research

Inventory facilities. Determine barrier performance limits. Develop better accident and exposure information. Monitor performance of barriers. When working on a facility, take the opportunity to upgrade, if possible. Document any planning and replacement activities. Recommend research to develop a management plan for the removal and replacement of obsolete or older barrier. Survey the states for practices in this regard.

Update manuals as new standards are developed (i.e., don't rely on memoranda). Need simple manuals and training for maintenance staff. Design standards generally apply to new construction; these should be considered as guidelines and not absolutes. Reasonable engineering judgement has its place. The new roadside design text should cover funding, priorities and warrants; this document should be helpful in court. Recommend research to develop innovative ways to keep maintenance personnel informed.

A tort committee involving legal and engineering staff would be helpful. Advantages to have in-house legal specialist(s) in tort law. More training for engineers in regard to legal issues; role playing in California DOT has been helpful. Consider teaching tort law to engineering students. Recommend A2A04 subcommittee to examine what pertinent information is available from the states.

Need procedure for identifying locations prioritizing needs and documenting plans and actions. Avoid interdepartmental friction in regard to action items. Be careful about the language used in reports; words like "hazardous" can have profound legal implications.

Suggested Solution or Recommended Research

Need inventories of roadside features and rational assessment of risk. Re-inventory when standards change. Need periodic review of roadway conditions to determine if barrier changes are needed. Use inventories, accident and exposure data to develop and upgrading program. Documentation very important. When standard plans or specifications are changed, record reasons in a permanent file or publication. At the program level, document: (1) the older features and the problems they create, (2) available new features and their advantages, and (3) the resources

available to provide the new as well as satisfy other needs. Research report authors should be careful not to unnecessarily downgrade older designs simply to inflate the newer designs. Be careful in the language used to describe older systems; terms like "obsolete," "substandard," etc., can have far-reaching consequence.

National research should be initiated to attempt to outline a process transportation agencies should use to upgrade older roadside features. The new AASHTO guide will not be comprehensive enough to satisfy this need. Recent and ongoing hardware research will be helpful in deciding where upgrading is needed. Examples include previous research at SwRI on bridge rail retrofit; the effectiveness of barriers with lowered rail heights due to soil buildup, overlays, etc., and retesting of barriers with lighter weight vehicles.

2. Problems of accidents occurring at hazardous locations (Item #2).

Accident statistics on specific highway locations and also on certain types of features and hardware are prerequisites in a program to improve roadway safety. Legal statistics concerning number and total dollar value of tort claims by highway feature and for hardware could also be quite useful in a safety program. Citizen complaints should initiate a review of available data to determine if corrective measures are necessary.

3. Failure of highway agencies to follow their own design manuals (Item #3).

Failure to conform to manuals is the single most effective weapon possessed by a claimant's lawyer. On the other hand, conformance also proves to be a effective defense. Manuals should receive legal review as to language problems and unattainable goals. Deviations from standards should be documented at the time the decision is made. There should be continuing training of personnel regarding standards pertinent to their work and the necessity of documentation of deviations.

4. Lack of communication between the engineering and legal divisions of a highway agency (Item #4).

Recommend staff meetings between engineers and attorneys at the state level as well as joint committees at national level. Annual reports summarizing engineering problems would be helpful. Standardized packets of information for common types of legal cases would also be helpful. There is concern that engineers and/or attorneys who specialize in certain types of cases can experience "burnout". Recommend research to develop a national tort claim data bank by establishing reporting methods and incorporating actual claim statistics into engineering decisions.

5. Pavement surface and edge discontinuities (Item #11).

Distribute recent and upcoming reports to states for their consideration. Research recommended to examine accident tort claim data, followed by the testing of drivers in various situations, to determine if the testing translates into similar actions by the average unsuspecting driver.

Group 4
Problem/Issue Prioritized

1. Lack of communication between the engineering and legal divisions of a highway agency (Item #4).

Suggested Solution or Recommended Research

Recommend: (1) permanent committee of engineers and attorneys at state and national level, (2) annual report of court actions by problem areas, (3) standardized information packets for similar cases, and (4) specialization by case type among engineers/attorneys. Recommend research to develop national data bank in regard to tort claims.

2. Obsolete or older barriers and restoration of damaged, substandard hardware (Items #1 and #7).

Upgrading program should be based on history and surveillance. Document why treatment is or is not to be done. Short installations should be upgraded when

- 3. Problem of accidents occurring at hazardous locations (Item #2).
 damaged. Long installations should be upgraded when major portion damaged; otherwise, replace in-kind.
 Recommend statewide accident surveillance system with procedures for identifying problem locations. Apparent problem areas require investigation and report. Reporting language should be factual and non-inflammatory. Citizen complaints should be handled promptly, courteously and objectively. Record of time, date and action should be made of citizen complaints.
- 4. Pavement surface and edge discontinuities (Item #11).
 Disseminate previous and upcoming reports about corrective actions to the states.
- 5. Failure of highway agencies to follow their own design manuals (Item #3).
 Manuals to be carefully drafted to reflect reality. Language in manuals should not mandate procedures. Continuing training programs necessary to keep staff current. Training must extend to worker level to both serve the public and prevent legal problems.

Perhaps to be expected, there was wide diversity among the groups as to priority problems/issues. Part of this is certainly due to the varied backgrounds of individuals composing the groups. Tables 5 and 6 present the priorities for each discussion group. In regard to the topic of Planning, Design and Construction (Table 5), Items 3 ("unusual" conditions) and 5 (problems in

construction zones) each appeared in the top-five issues of all four groups, while Items 2 (accidents at hazardous locations), 4 (lack of communication between engineering and legal divisions,) and 11 (pavement surface and edge discontinuities) each received top-five ratings in three of the four groups.

TABLE 5. Group priorities for the topic of Planning, Design and Construction.

Item	Priorities Group			
	1	2	3	4
1. "Innocent bystander"	1	4	3	4
2. Lack of cost/benefit procedures	2			
3. "Unusual" conditions	3	2	3	
4. Wider range of impact conditions				3
5. Problems in construction zones	4	3		5
6. Trails much later in time than accident			2	
7. Treating utility poles		5		
8. Guardrail end treatment				1
9. Lack of compatibility between vehicle and highway designers				
10. Spot safety upgrading			4	
11. Design for perons "legally" using the roadway	5			
12. Standards for scenic highways, roads, etc.				
13. Improper signing				
14. Lack of communication of available engineering knowledge to design, construction and maintenance personnel	1			
15. Lack of feedback regarding tort claims		1		
16. Lack of Model Tort Liability Act			1	
17. Unqualified expert witnesses			5	
18. Timing of standards relative to research				2

TABLE 6. Group priorities for the topic of Operations and Maintenance.

Item	Priorities Group			
	1	2	3	4
1. Problems with older barriers		1	1	
2. Accidents at hazardous locations		4	2	3
3. Failure to follow design manuals	5	2	3	5
4. Lack of communication between engineering and legal divisions	2		4	1
5. Lack of communication between states and agencies				
6. Need for vegetation control				
7. Restoration of damaged, substandard hardware				
8. Routine maintenance of safety devices				
9. Roadside features not controlled by the highway agency				
10. Operational versus preventive maintenance				
11. Pavement surface and edge discontinuities	1		5	4
12. Combine #8 and #10	3			
13. Combine #1 and #7	4			2
14. Combine #4 and #5		3		

Having heard all the group summaries and rankings, participants were given one final opportunity to rank the problems/issues discussed at the workshop. A follow-up survey was mailed to each attendee, as well as other members of the Safety Appurtenances Committee. Listed were most of the original problems/issues in both the Planning, Design and Construction category (Table 3) and the Operations and Maintenance category (Table 4), as well as any additions receiving a top-five priority ranking from any of the separate groups. A few of the items from each category were deleted, while others were combined to follow the desire of the discussion groups. The complete listing of items by category is shown Tables A1 and A2 Appendix A.

Each recipient of the survey was asked to rank each problem/issue on a scale from 0 to 8, with the priority being represented by:

Low		Moderate		High
0 1	2	3 4 5	6	7 8

The questionnaire was mailed in late January, 1985, and most of the 33 responses were received in February, 1985.

Table 7 shows the results of the survey for the topic of Planning, Design, and Construction, and several points are rather apparent. First, an examination of the mean values for each problem/issue shows very little variation (range of 4.15 to 5.84), and all problems/issues have mean priority values of moderate. Second, the standard deviations show a large amount of spread. Third, the spread is confirmed by the range values, where all are either 6 or 7. In other words, there was considerable disagreement among the 33 respondents concerning the priority of each problem/issue.

The problem/issue with the largest mean value (i.e., the highest overall priority) concerned the need for more state-of-the-art training of design, construction and maintenance personnel. Interestingly, this issue was ranked highly at other Safety Appurtenances Committee summer meetings involving different attendees. Problems in construction zones was ranked second in priority; this issue had received high priority at the meeting (Table 5). Third place was a tie between the need for benefit/cost procedures and developing effective end treatments, although the latter had a smaller standard deviation. Next in order was how to undertake spot safety upgrading.

The results for the topic of Operations and Maintenance show more spread in the mean values and lower standard deviations (Table 8), although the ranges are still quite large. Examining the mean values shows that the top five problems/issues (2,1,4,3, and 6, respectively) fall between 5.8 and 6.5, with a sharp dropoff thereafter. Dealing with accidents at hazardous locations was the top-ranked problem, and decisions, followed closely by the failure to follow design manuals. The fifth ranked problem/issue focused on the schedule of maintenance of safety features. These results matched well with those from the actual meeting (Table 6).

Some of the disagreement between the results from the summer meeting and the follow-up survey for the Planning, Design, and Construction topic can probably be explained by two factors: (1) the survey was mailed about 5 months after the meeting, so that the issues were not as fresh, and (2) the survey included members of the TRB Safety Appurtenances Committee who did not attend the meeting.

TABLE 7. Follow-up survey results for the topic of Planning, Design and Construction.

Problem/Issue	Mean	Standard Deviation	Range
1. Innocent bystander	4.74	1.88	7
2. Use of benefit/cost procedures	5.64	2.03	7
3. Unusual conditions	4.64	2.22	7
4. Range of impact conditions	4.52	2.12	7
5. Construction zones	5.67	1.66	6
6. Trial date	4.56	1.97	7
7. Treating utility poles	5.19	2.15	7
8. Guardrail end treatment	5.64	1.93	7
9. Spot safety upgrading	5.58	1.77	7
10. Design for persons "legally" using highway	4.15	1.92	7
11. Personnel training	5.84	2.10	7
12. Feedback on tort litigation	5.30	1.86	6
13. Model Tort Liability Act	5.27	2.45	7
14. Unqualified expert witnesses	5.47	2.20	7
15. Timing of adoption of standards	5.03	1.96	6

TABLE 8. Follow-up survey results for the topic of Operations and Maintenance.

Problem/Issue	Mean	Standard Deviation	Range
1. Restoring and upgrading safety features	6.42	1.89	7
2. Accidents at hazardous locations	6.49	1.42	6
3. Failure to follow design manuals	5.94	1.50	6
4. Problems of communication	6.09	1.51	5
5. Need for vegetation control	3.52	1.91	6
6. Maintenance of safety features	5.76	1.64	6
7. Roadside features not controlled by highway agencies	4.30	1.85	7
8. Pavement surface and edge discontinuities	5.03	1.67	7